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COSTS AND RETURNS OF MANAGING 100,000 ACRES OF SHORTLEAF AND LOBLOLLY PINE FOR SUSTAINED YIELD

by

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The Occasional Papers of the Southern Forest Experiment Station present information on current southern forestry problems under investigation at the Station. In some cases these contributions were first presented as addresses to a limited group of people, and as "occasional papers" they can reach a much wider audience. In other cases, they are summaries of investigations prepared especially to give a report of the progress made in a particular field of research. In any case, the statements herein contained should be considered subject to correction or modification as further data are obtained.

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Satisfactory commercial forest management not only must produce continuous yields of merchantable forest products but also it must produce them with a reasonable margin of returns over costs. During recent years several large companies in the South have insured the permanence of their operations by adopting sustained-yield forest management. These operations have not progressed far enough to disclose the ultimate financial possibilities of this type of management, but present studies of costs and returns indicate that it is economically practical and financially attractive.

The purpose of this paper is to show the financial possibilities of managing existing large properties, composed chiefly of second-growth shortleaf and loblolly pine, for sustained yield, starting with unmanaged natural stands. A property of over 100,000 acres in the Upper Coastal Plain has been selected as an illustration, and the costs and returns of sustained-yield management over a period of 30 years have been estimated. The forest types and conditions that comprise this forest, and the area, volume of stands, and increment in each type and condition, have been determined by a line-plot survey, although some of the minor types have been combined and the areas of the different classes of timber have been changed sufficiently to maintain secret the identity of the property.

When available, the costs and returns computed in this paper are those actually applying to the 100,000 acres and when not available, they were obtained from economic investigations of private forestry under similar forest and economic conditions. Although the computed costs and returns are better than those obtained from average forest stands of the Upper Coastal Plain, they are nevertheless conservative and can be obtained on many large properties under present economic conditions. It should be clearly understood, however, that the figures given apply to the property described and can not be applied safely to other properties without taking into consideration the volume and growth of the growing stock, productive capacity of the site, and available markets.

Lumbering operations have been conducted continuously on this property for more than 30 years. During the early part of this period only the largest and best trees were cut, but during the greater portion of the period practically all merchantable trees at least 10 inches in diameter at breast high (d.b.h.) were removed. A few years ago, minimum diameter limits of 14 inches for pine and 16 inches for hardwoods were adopted, and 2 years ago selective cutting was put into practice. All trees are now marked by an experienced man before cutting. Reasonably good fire protection has been practiced for about 13 years, resulting in excellent stands of reproduction and saplings. Most parts of the property are accessible to trucks over improved public or ungraded community roads, and during the past few years additional roads built by the CCC have made truck logging much more economical than previously.

Growing stock and growth

About 70 percent of the forest property here discussed is occupied by second-growth pine stands, in which loblolly pine makes up about two-thirds and shortleaf pine about one-third of the volume. The remaining 30 percent of the area is occupied by old-growth pine, old-field pine, and bottom hardwoods. The following tabulation gives the areas and the total and per-acre volumes (lumber tally) for each forest condition:

Forest condition	Area	Total volume		Volume per acre	
		Pine	Hardwood	Pine	Hardwood
	Acres	- - - - - - - - - - Board feet 1/ - - - - - - - - -			
Old-growth pine	5,000	90,000,000	1,500,000	18,000	300
Second-growth pine	70,000	217,000,000	24,500,000	3,100	350
Old-field pine	18,000	36,000,000	-	2,000	-
Bottom hardwoods	7,000	-	23,800,000	-	3,400
Totals, or averages	100,000	343,000,000	49,800,000	3,430	498

1/ Lumber tally in pine trees at least 10 inches d.b.h. and in hardwoods at least 14 inches d.b.h.

Only a small remnant of the total forest area remains in old-growth stands. These are composed chiefly of virgin pines, many of which should be removed because they are defective and rapidly depreciating in value. They also contain much young timber that has replaced the veterans lost through natural causes.

The second-growth stands range in density of saw-timber growing stock from well-stocked stands with 4,000 - 7,000 board feet (lumber tally) per acre down to cut-over areas with less than 1,000 board feet per acre. They are generally composed of trees of many age-classes, including well-stocked patches of reproduction and samplings as well as saw-timber trees. These irregular stands are well suited to selective-timber management. During the first 10-year cutting cycle, some of the lightest stands will not be cut for sawlogs, and consequently the average volume of the growing stock per acre on the cut-over areas will be considerably above 3,100 board feet, the average volume for all second-growth stands. The average stand per acre of 350 board feet of merchantable hardwoods does not accurately depict the stand, because there is a rather large number of undesirable hardwoods, some left from the original cut, which are unsuitable for sawlogs and therefore not included in the saw-timber volume. There are also some pine trees of saw-timber size that are unsuitable for sawlogs. As a general rule, both these pines and hardwoods should be removed in order to make room for trees of higher quality.

Most of the old-field pine stands are even-aged and composed almost entirely of pine in the upper stories, but hardwoods are coming into the lower stories. Stands range in age from those composed largely of saw-timber trees to stands of saplings, but the most prevalent age-class is the pole stand which will grow into saw-timber during the next 10 years. The quality of old-field trees is generally not as high as that of trees in natural second-growth stands. Also there are many limby individuals that will never grow into high-quality saw-timber trees; these should be removed at an early date for pulpwood.

The bottom hardwoods are composed of stands ranging from those recently cut-over (which now bear trees below merchantable size, defective individuals, and unmerchantable species with practically no merchantable saw-timber trees remaining) up to those from which only a few of the largest and best trees were cut many years ago and which now contain some hardwood timber of a very high quality. Most of the stands are unevenaged. Selective-timber management has been tried very little in the hardwoods, but where markets exist for the poor species and low-quality trees it should prove very effective.

A growth study of the property gave the following net growth figures for the different forest conditions after deducting for natural mortality:

Forest condition	Area	Net annual growth per acre		Total annual growth	
		Pine	Hardwood	Pine	Hardwood
	Acres	- - - - - - - -		Board feet 1/	- - - - - - - -
Old-growth pine	5,000	250	10	1,250,000	50,000
Second-growth pine	70,000	186	15	13,020,000	1,050,000
Old-field pine	18,000	300	-	5,400,000	-
Bottom hardwoods	7,000	-	200	-	1,400,000
Totals	100,000	197	25	19,670,000	2,500,000

1/ Lumber tally in pines at least 10 inches d.b.h. and in hardwoods at least 14 inches d.b.h.

The net growth in board feet per acre in old-growth stands will be increased considerably by cutting the defective old trees, thus reducing natural mortality and giving more space to the vigorous healthy individuals. Likewise, by selecting for cutting the poorer trees and limiting the cut to less than the growth, the saw-timber growing stock in second-growth stands will be built up and the increment increased. Proper thinnings, removing the poorer trees and reserving the most thrifty and best trees, will stimulate growth in old-field stands.

Management practices

Selective-timber management with a 10-year cutting cycle has been adopted by a large number of lumber companies on large properties in the shortleaf and loblolly pine type. This method of management, which combines good economics and good silviculture, is selected for this example. Studies made by the Southern Forest Experiment Station have shown that it is practical, since volumes as low as 500 board feet per acre can be removed with trucks at only a slightly higher logging cost than volumes of 2,000 - 4,000 board feet per acre. This method removes the non-earning and low-earning timber in the order of its financial maturity and saves the rapidly-growing higher-earning timber until it approaches financial maturity. In practice, however, it may be necessary to cut trees before they are financially mature in order to supply the mill with sawlogs, but this should not be done if logs can be purchased on the open market. Cost-production studies made by the Southern Station have shown that, when only the more mature and the defective trees are cut selectively, higher grades of lumber and considerably higher returns per M board feet of cut are obtained than when clear-cutting is practiced. Lower costs of logging and milling per M board feet also

result. The following values for second-growth pine stumpage (including all timber-growing costs and profit) were obtained from this study:

D.b.h. Inches	Stumpage value	
	Per tree	Per M bd.ft.
12	$.11	$1.43
15	.65	4.04
18	1.87	8.28
22	5.28	9.91

Under good management in second-growth stands, the periodic cut of saw timber should not exceed that amount which the residual stand will restore by growth during the ensuing 10-year period. Because of understocking in most stands, it is desirable to cut less than the growth in order to build up the growing stock and direct the productive capacity of the soil toward its maximum sustained production of high-quality timber. Studies indicate that second-growth stands should contain at least 10,000 board feet (lumber tally) per acre before the entire amount of the growth is removed at the time of each cut. The second-growth stands on this property, which average only 3,100 board feet of pine per acre, are decidedly understocked. With timber growing at 6 percent compounded—about the present rate of growth of the second-growth pine stands on this property—approximately 44 percent of the volume of the saw timber can be removed without depleting the growing stock, since the residual stand will restore this volume through growth during the ensuing 10 years. In order to build up the growing stock on this property, however, it is proposed to limit the cut to approximately 30 percent of the volume of the saw-timber growing-stock in the second-growth pine and bottom-hardwood stands during the first two 10-year periods, and to increase this to 33-1/3 percent in the third period. In the old-field stands, no cut of saw timber is contemplated during the first 10 years, but cuts during the following periods will be about the same as in the second-growth pine stands. In the old-growth, however, a much heavier cut is desirable in order to remove the decadent trees and give more growing space to the reserved, thrifty trees. In order to facilitate regulation of the cutting, a large property of 100,000 acres would be divided into 2 or more large blocks and each block into smaller permanent management units.

This tract, which has had no previous management, is in need of an immediate improvement cutting. Trees that are defective and of poor form or low vigor should be removed, the young growth should be thinned, and hardwoods of inferior species should be removed. As a result of the building of many new pulpmills in the South, there is a widespread market for pulpwood, and a stumpage price of about 75¢ a cord can be obtained at the present time. In many cases the low-quality hardwoods can be disposed of for fuel wood, railroad ties, chemical wood, or fence posts at a small price for stumpage. Cost-production studies of hardwoods removed in improvement cuttings for chemical wood showed a margin for stumpage above all costs of production and marking of about 25¢ a cord. Thinnings and improvement cuttings are desirable in building up the volume, and especially the quality, of saw-timber growing stock, if they can be made without loss. Where markets for pulpwood and fuel wood do not make these operations profitable, stand improvement must proceed more slowly. Improvement cuttings for pulpwood and other inferior products can be made to best advantage in conjunction with the cutting of sawlogs, since the tops of saw-timber trees are commonly utilized for pulpwood,

fuel wood, or other low-grade products, along with the trees removed in the improvement cuttings. Studies have shown that for each 1,000 board feet of logs cut in second-growth pine timber, 0.38 cords of pulpwood can be cut from tops and from the trees seriously injured by logging.

Estimated costs and returns

The primary product of this forest is sawlogs, chiefly pine, and the secondary products are pine pulpwood and hardwood fuel wood, ties, or other products, depending upon available markets.

The primary aim of management is gradually to build up the growing stock in quantity and quality until the maximum sustained production of the forest is obtained along with the greatest net returns. Although a sufficient volume will be cut to maintain a profitable operation, the full amount of growth will be cut only in the old-growth stands, in order that a portion may be reserved and added to the growing stock. It should be realized, however, that the full amount of growth could be cut without reducing the capital value of the property, and that the growth reserved and added to the capital value is a part of the income, even if it is not taken at this time. The cut of sawlogs will be increased gradually during each succeeding 10-year period in all understocked stands until full stocking is achieved, when the total volume of growth will be cut. The quality of the sawlogs and their value per M board feet also will increase gradually under a selection method which shifts growth from trees of poor form and vigor to better ones. In order to improve all stands on the tract by selective cutting, it is planned to cut during each 10-year period in all stands in which commercial operations are profitable; in other words, approximately 10,000 acres will be cut over each year, or the entire 100,000 acres will be cut over in 10 years. This is very feasible with truck logging, but some additional gravel roads must be constructed for wet-weather logging. Carefully planned and efficiently constructed all-weather roads over a period of years are less costly than the main-line railroads and spurs used in past operations.

In the following calculations of yields and growth, the stands for each forest condition at the mid-point of each 10-year period were accepted as the average stands for that period. In the first 10-year period, these were obtained by adding 5 years growth, as determined by the growth study, to the present stands in each forest condition. For the two succeeding 10-year periods, the average stands were obtained by adding 10 years growth to the stands after the preceding periodic cut was made. Compounded growth rates of 6 percent for second-growth and old-field pine, 5 percent for second-growth upland and bottom hardwoods, and 4 percent for the old-growth pine and hardwoods, were used.

Tables 1 and 2 present data that summarize the results of management through the next 30 years. All figures have been computed on a per-acre basis. The per-unit values of stumpage for the three periods are given in tables 3, 4, and 5.

Table 1.- Estimated volumes of saw timber[1], and cuts and growth per average acre by forest conditions for three 10-year periods

Item	Beginning 1st 10-year period		Mid-point 1st 10-year period		Mid-point 2nd 10-year period		Mid-point 3rd 10-year period		End of 3rd 10-year period	
	Pine	Hdwd.	Pine	Hdwd.	Pine	Hdwd.	Pine	Hdwd.	Pine	Hdwd.
	Board feet (lumber tally)									
Old-growth pine										
Stand before cut	18,000	300	19,250	350	14,800	296	14,800	296	12,170	243
Stand after cut	-	-	10,000	200	10,000	200	10,000	200	-	-
Volume cut	-	-	9,250	150	4,800	96	4,800	96	-	-
Growth added to growing stock	-	-	-	-	-	-	-	-	-	-
Total growth since last cut	-	-	2/ 1,250	2/ 50	4,800	96	4,800	96	2/ 2,170	2/ 43
Average annual growth	-	-	250	10	480	10	480	10	434	9
Second-growth pine										
Stand before cut	3,100	350	4,030	425	5,068	489	6,390	552	5,700	468
Stand after cut	-	-	2,830	300	3,568	339	4,260	367	-	-
Volume cut	-	-	1,200	125	1,500	150	2,130	185	-	-
Growth added to growing stock	-	-	-	-	738	39	692	28	-	-
Total growth since last cut	-	-	2/ 930	2/ 75	2,238	189	2,822	213	2/ 1,440	2/ 101
Average annual growth	-	-	186	15	224	19	282	21	288	20
Old-field pine										
Stand before cut	2,000	-	3,500	-	6,268	-	7,644	-	6,883	-
Stand after cut	-	-	3,500	-	4,268	-	5,144	-	-	-
Volume cut	-	-	-	-	2,000	-	2,500	-	-	-
Growth added to growing stock	-	-	1,500	-	768	-	876	-	-	-
Total growth since last cut	-	-	2/ 1,500	-	2,768	-	3,376	-	2/ 1,739	
Average annual growth	-	-	300	-	277	-	338	-	348	-
Bottom hardwoods										
Stand before cut	-	3,400	-	4,400	-	5,050	-	5,783	-	4,827
Stand after cut	-	-	-	3,100	-	3,550	-	3,783	-	-
Volume cut	-	-	-	1,300	-	1,500	-	2,000	-	-
Growth added to growing stock	-	-	-	-	-	450	-	233	-	-
Total growth since last cut	-	-	-	2/ 1,000	-	1,950	-	2,233	-	2/ 1,044
Average annual growth	-	-	-	200	-	195	-	223	-	209

1/ Pine trees 10 inches d.b.h. and larger and hardwoods 14 inches d.b.h. and larger.
2/ Total volume of growth during 5 years.

Table 2. - Estimated value of saw-timber[1] cuts and growth per average acre by forest conditions for three 10-year periods

Item	Mid-point 1st 10-year period		Mid-point 2nd 10-year period		Mid-point 3rd 10-year period		End of 3rd 10-year period	
	Pine	Hdwd.	Pine	Hdwd.	Pine	Hdwd.	Pine	Hdwd.
	Dollars							
Old-growth pine								
Volume cut	69.37	1.12	40.80	.82	40.80	.82	-	-
Growth added to growing stock	-	-	-	-	-	-	-	-
Total growth since last cut	[2] 9.37	[2] .37	40.80	.82	40.80	.82	[2] 18.44	[2] .37
Average annual growth	1.87	.07	4.08	.08	4.08	.08	3.69	.07
Second-growth pine								
Volume cut	6.00	.62	9.00	.90	14.91	1.29	-	-
Growth added to growing stock	-	-	4.43	.23	4.84	.20	-	-
Total growth since last cut	[2] 4.65	[2] .37	13.43	1.13	19.75	1.49	[2] 10.08	[2] .71
Average annual growth	.93	.07	1.34	.11	1.97	.15	2.02	.14
Old-field pine								
Volume cut	-	-	8.00	-	12.50	-	-	-
Growth added to growing stock	6.00	-	3.07	-	4.38	-	-	-
Total growth since last cut	[2] 6.00	-	11.07	-	16.88	-	[2] 8.70	-
Average annual growth	1.20	-	1.11	-	1.69	-	1.74	-
Bottom-hardwoods								
Volume cut	-	6.50	-	9.00	-	14.00	-	-
Growth added to growing stock	-	-	-	2.70	-	1.63	-	-
Total growth since last cut	-	[2] 5.00	-	11.70	-	15.63	-	[2] 7.31
Average annual growth	-	1.00	-	1.17	-	1.56	-	1.46

1/ Pine trees 10 inches d.b.h. and larger and hardwoods 14 inches d.b.h. and larger.
2/ Total value of growth for 5 years.

Table 3 shows the volumes of yields and gross returns from pine and hardwood stumpage cut as saw timber, pulpwood, and fuel wood during the first 10-year period. The stumpage values used for saw timber are somewhat higher than present current stumpage prices, but these values have been obtained on U. S. Forest Service sales and can be obtained by efficient managers for stumpage produced under good forest management. Cost-production studies made by the Southern Forest Experiment Station in similar timber, and of pulpwood and fuel wood production,have shown that the stumpage prices for these products are reasonable. Although pulpwood markets have greatly expanded over the South during the past 2 years, some owners do not yet have a market for pulpwood. In many more localities, moreover, there is not a ready market for hardwood fuel wood on a large scale, but the future market for low-quality hardwoods appears to be more favorable. If such markets do not exist, of course, the forest owner has only his income from saw timber.

Table 4 shows for the second 10-year period the volumes and gross values of stumpage cut as saw timber, pulpwood, and fuel wood. Stumpage values of saw timber have been increased over those of the first 10-year period because the quality of logs cut will be considerably higher than that of logs cut during the first 10-year period and not because of any increase in the general market prices of stumpage. The cut of sawlogs is also heavier for the property as a whole, because the volumes of growing stock and of increment are considerably greater than they were during the previous period.

Table 5 shows volumes and gross values of stumpage cut during the third 10-year period.

It should be observed that only the values of timber cut have been included in these gross yields and returns; although the gross yields and incomes represented by the growth reserved from cutting(and added to the growing stock) might well be included, they have not been.

A comparison of tables 3 and 5 shows that the cut of saw timber increased from 148,850 M board feet during the first 10-year period to 245,530 M board feet during the third 10-year period, while the gross values of sawtimber stumpage increased from $861,750 to $1,665,430. The total gross income from all products increased from $104,650 per year, or $1.046 per acre per year, for the first period to $179,255.50 per year, or $1.793 per acre per year, for the third period.

For a large property, the costs of forest management include taxes, fire protection, inventory, marking of timber for cutting, and supervision of the cutting. Most owners of large forest properties do not consider interest on the money invested in the property as a cost unless actually paid out on borrowed money, and so interest is not included in this paper. In the case of operating lumber companies the costs of supervision of cutting and, in many cases, the marking of timber are considered as costs of logging, but in this paper, which is limited to timber management, they are considered as costs of growing stumpage.

Taxes vary from state to state and also from county to county within states. An annual tax of 12¢ per acre has been accepted as representative for large properties in this forest region. With the building up of the growing stock and the resulting increased gross income, taxes on the property may be increased. The present tendency in the South, however, is to lower

Table 3.- Yields and gross returns - first 10-year period

Products by timber classes	Area	Yield per acre		Total yield			Gross returns	
		Pine	Hardwood	Pine	Hardwood	Total	Per unit	Total
	Acres	Board feet		M Board feet			Dollars	
Saw timber[1/]								
Old-growth	5,000	9,250	150	46,250	750	47,000	7.50	352,500
Second-growth	70,000	1,200	125	84,000	8,750	92,750	5.00	463,750
Bottom hardwoods	7,000	-	1,300	-	9,100	9,100	5.00	45,500
Total saw timber				130,250	18,600	148,850		861,750
Pine pulpwood[2/]		Cords		Cords				
Second-growth	70,000	1½		105,000			.75	78,750
Old-field	18,000	5		90,000			.75	67,500
Total				195,000				146,250
Hardwood fuel wood[2/]				Cords				
Second-growth	70,000	2		140,000			.25	35,000
Bottom hardwoods	7,000	2		14,000			.25	3,500
Total				154,000				38,500
Total gross returns first 10-year period								1,046,500.00
Total gross returns per year								104,650.00
Total gross returns per acre per year								1.046

1/ Pine trees 10 inches d.b.h. and larger and hardwoods 14 inches d.b.h. and larger. Volumes are in board feet lumber tally.

2/ Cut from trees removed in improvement cuttings and thinnings and from tops of trees felled in logging. Volumes are in standard cords (4 x 4 x 8 ft.).

Table 4.- Yields and gross returns - second 10-year period

Products by timber classes	Area	Yield per acre		Total yield			Gross returns	
		Pine	Hardwood	Pine	Hardwood	Total	Per unit	Total
	Acres	Board feet		- - -	M Board feet	- - - -	- - - -Dollars	- - - -
Saw timber[1/]								
Old-growth	5,000	4,800	96	24,000	480	24,480	8.50	208,080
Second-growth	70,000	1,500	150	105,000	10,500	115,500	6.00	693,000
Old-field	18,000	2,000	-	36,000	-	36,000	4.00	144,000
Bottom hardwoods	7,000	-	1,500	-	10,500	10,500	6.00	63,000
Total saw timber				165,000	21,480	186,480		1,108,080
Pine pulpwood[2/]								
		Cords		Cords				
Second-growth	70,000	1		70,000			.75	52,500
Old-field	18,000	1½		27,000			.75	20,250
Total				97,000				72,750
Hardwood fuel wood[2/]								
				Cords				
Second-growth	70,000	1		70,000			.25	17,500
Bottom hardwoods	7,000	2		14,000			.25	3,500
Total				84,000				21,000
Total gross returns second 10-year period								1,201,830.00
Total gross returns per year								120,183.00
Total gross returns per acre per year								1.202

1/ Pine trees 10 inches d.b.h. and larger and hardwoods 14 inches d.b.h. and larger. Volumes are in board feet lumber tally.

2/ Cut from trees removed in improvement cuttings and thinnings and from tops of trees felled in logging. Volumes are in standard cords (4 x 4 x 8 ft.).

Table 5.- Yields and gross returns - third 10-year period

Products by timber classes	Area	Yield per acre		Total yield			Gross returns	
		Pine	Hardwood	Pine	Hardwood	Total	Per unit	Total
	Acres	Board feet		- - - - M Board feet - - - -			- - - - Dollars - - - -	
Saw timber[1/]								
Old-growth	5,000	4,800	96	24,000	480	24,480	8.50	208,080
Second-growth	70,000	2,130	185	149,100	12,950	162,050	7.00	1,134,350
Old-field	18,000	2,500	-	45,000	-	45,000	5.00	225,000
Bottom hardwoods	7,000	-	2,000	-	14,000	14,000	7.00	98,000
Total saw timber				218,100	27,430	245,530		1,665,430
Pine pulpwood[2/]								
		Cords		Cords				
Old-growth	5,000	1		5,000			.75	3,750
Second-growth	70,000	1½		105,000			.75	78,750
Old-field	18,000	1 3/4		31,500			.75	23,625
Total				141,500				106,125
Hardwood fuel wood[2/]								
					Cords			
Second-growth	70,000	1			70,000		.25	17,500
Bottom hardwoods	7,000	2			14,000		.25	3,500
Total					84,000			21,000
Total gross returns third 10-year period								1,792,555.00
Total gross returns per year								179,255.50
Total gross returns per acre per year								1.793

1/ Pine trees 10 inches d.b.h. and larger and hardwoods 14 inches d.b.h. and larger. Volumes are in board feet lumber tally.

2/ Cut from trees removed in improvement cuttings and thinnings and from tops of trees felled in logging. Volumes are in standard cords (4 x 4 x 8 ft.).

rather than to raise taxes on forest properties. In this example, taxes have been set at 15¢ per acre per year during the second 10-year period and at 20¢ during the third period.

Fire protection is furnished to forest owners in the shortleaf and loblolly pine type in most Southern States for about 2¢ per acre per year by the states cooperating under the Clarke-McNary Act. A cost of 3¢ has been used, however, so that some additional fire-suppression work may be provided.

Studies of costs of marking and at the same time making 100-percent cruises of second-growth saw timber show that costs amount to about 10¢ per M board feet cut. Marking pulpwood and chemical wood costs about 3½¢ per cord. It is estimated that 20¢ per M board feet and 7¢ per cord will cover adequately all costs of cruising, marking, and supervising of cutting.

Table 6 gives the costs, excluding interest on the investment, of managing the whole property for each of the three 10-year periods.

The net returns, including stumpage, interest, and profit, for the whole property during the first 10-year period is the gross income of $1,046,500 minus the total expenses of $204,200, or $842,300. On an annual per-acre basis, this is $.842. For the second 10-year period the net income has increased to $971,864 for the property as a whole, or $.972 per acre per year; and for the third 10-year period, to $1,497,664 for the property as a whole, or $1.498 per acre per year. For the 30-year period the net income amounts to $3,311,828, or $1.104 per acre per year. Here, as in computing gross incomes, the values of growth added to the growing stock have not been considered in computing net incomes.

The following table gives the estimated value of this property based on current market values of land and stumpage. It should be pointed out, however, that companies owning valuable properties, are not offering them for sale, but rather are practicing continuous forest management. Good properties, nevertheless, can often be blocked up by purchasing a number of smaller properties.

100,000 acres of land, exclusive of timber, at $3.00 per acre	$300,000
91,500 M bd. ft. of virgin timber at $5.00 per M bd. ft.	457,500
301,300 M bd. ft. of second-growth timber at $3.00 per M bd. ft.	903,900
Total value	$1,661,400
Average value per acre	$16.61

It will be noted that the current market values of stumpage used in the above table are less than those applied to the stumpage cut during the first 10-year period. This is quite logical, since it is to be expected that purchasers of tracts of forest land will drive some sharp bargains and, furthermore, they cannot be expected to pay the same price for stumpage to be held for some years before cutting as would an operator who is purchasing stumpage that will be cut immediately. The quality of stumpage, which on a purchased area includes all pines of saw-timber quality 10 inches d.b.h. and larger and all hardwoods 14 inches d.b.h. and larger, is much lower than that of stumpage in trees marked for cutting during the first 10-year period.

Table 6.- Costs of management

	Dollars
1st 10 years	
Taxes at 12¢ per acre per year (100,000 acres)	120,000.00
Fire protection at 3¢ per acre per year (100,000 acres)	30,000.00
Marking, estimating, supervision for sawlog cutting at 20¢ per M bd. ft. (148,850 M bd.ft.)	29,770.00
Marking and supervision for cutting pulpwood at 7¢ per cord (195,000 cords)	13,650.00
Marking and supervision for cutting hardwood fuel wood at 7¢ per cord (154,000 cords)	10,780.00
Total cost 10 years	204,200.00
Total cost per year	20,420.00
Total cost per acre per year	.204
2nd 10 years	
Taxes at 15¢ per acre per year (100,000 acres)	150,000.00
Fire protection at 3¢ per acre per year (100,000 acres)	30,000.00
Marking and supervision for sawlog cutting at 20¢ per M bd.ft. (186,480 M bd.ft.)	37,296.00
Marking and supervision for cutting pulpwood at 7¢ per cord (97,000 cords)	6,790.00
Marking and supervision for cutting hardwood fuel wood at 7¢ per cord (84,000 cords)	5,880.00
Total cost 10 years	229,966.00
Total cost per year	22,996.60
Total cost per acre per year	.230
3rd 10 years	
Taxes at 20¢ per acre per year (100,000 acres)	200,000.00
Fire protection at 3¢ per acre per year (100,000 acres)	30,000.00
Marking and supervision for sawlog cutting at 20¢ per M bd. ft. (245,530 M bd.ft.)	49,106.00
Marking and supervision for cutting pulpwood at 7¢ per cord (141,500 cords)	9,905.00
Marking and supervision for cutting hardwood fuel wood at 7¢ per cord (84,000 cords)	5,880.00
Total cost 10 years	294,891.00
Total cost per year	29,489.10
Total cost per acre per year	.295

The net incomes per acre per year for the three 10-year periods earn the following rates of interest annually on an investment value of $16.61 per acre:

10-year period	Net income per acre per year	Rate of interest earned on investment of $16.61 per acre
First	$.842	5.1
Second	.972	5.8
Third	1.498	9.0
Average	$1.104	6.6

If the additions to the growing-stock investment from saving growth are taken into consideration, however, these percents would be reduced in the second and third periods.

Attention has been called in several placed to the fact that the three cuts did not remove all of the growth made during each period. A part was reserved and added to the growing stock, thus increasing the volume and improving the quality of timber. The total volume of saw timber at the beginning of the first 10-year period was 343,000 M board feet of pine and 49,800 M board feet of hardwoods, and after 30 years, i.e., at the end of the third 10-year period, it is estimated as 583,744 M board feet of pine and 67,764 M board feet of hardwoods; this is a gain of 240,744 M board feet (70 percent) of pine and 17,964 M board feet (36 percent) of hardwoods. The net growth of both pine and hardwoods, which is added to the growing stock, amounts to 258,708 M board feet, which at $6.00 per M board feet has a gross value of $1,552,248. On an annual per-acre basis this amounts to an average of 86.2 board feet, or $.517, during the 30-year period. If this is added to the average net income of $1.104 per acre per year, received from the timber cut, the total becomes $1.621 per acre per year for the 30-year period. The following tabulation gives total and per-acre volumes by stand conditions at the end of 30 years:

Forest condition	Area	Total volume		Volume per acre	
		Pine	Hardwood	Pine	Hardwood
	Acres	Board feet 1/			
Old-growth pine	5,000	60,850,000	1,215,000	12,170	243
Second-growth pine	70,000	399,000,000	32,760,000	5,700	468
Old-field pine	18,000	123,894,000	-	6,883	-
Bottom hardwoods	7,000	-	33,789,000	-	4,827
	100,000	583,744,000	67,764,000	5,837	678

1/ Lumber tally in pine trees 10 inches d.b.h. and larger and in hardwoods 14 inches d.b.h. and larger.

Based on the calculations in this paper, therefore, sustained-yield management of large properties of shortleaf and loblolly pine is profitable. In fact, selective-timber management is currently more profitable than clear-cutting, because in the latter (1) many small immature trees are cut which yield little net income and may result in a loss; (2) depletion charges must be added to costs; (3) the depreciation costs are increased; and (4) the business must be concluded and new investments sought. Selective-timber management, on the other hand, is good business from the start. It gradually builds up the growing stock and at the same time yields progressively increasing net returns, which compare favorably with those from other sound investments.

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